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MODELLING OF HEAT MASS EXCHANGE PROCESSES AND DESIGN PROCEDURE OF INNOVATIVELY MODERNIZED SYSTEMS OF AERATION OF SHOPS WITH SURPLUSES OF WARMTH

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The article outlines the conceptual possibilities and methods of physico-mathematical modeling of static, dynamic and heat and mass transfer processes in the shops of the extract in terms of exposure to gravitational forces and wind pressure on the building when natural ventilation is active by a method of aeration by the "bottom-up".

Introduction. The technology of foundry manufacture is characterized by a considerable amount of heat, allocated in a working zone from technological furnaces, the process equipment, the heated and fused metals continuously or is long on time in the form of radiating radiant thermal energy from heated surfaces and a convection component of a thermal stream in the form of hot gases or overheated air owing to what working conditions of the working considerably worsen.

For improvement of quality of the air environment in hot shops the way of ventilation by a method of aeration by natural airing of a working zone of shop external supply ventilating air which arrives in premises through the special aeration supply apertures located in external walls of a building in two levels is used: for the summer period of year - in the bottom zone near to a premise floor, and for the winter period of year of an aperture are located at height $h = 4,5$ м from a floor.

Removal of ventilating air at building aeration is carried out through special aeration lanterns with the exhaust apertures located above a roof, or exhaust mines.

For quantitative regulation of the expense of ventilating air in supply and exhaust apertures adjustable lattices are established.

In the course of natural circulation of air streams in premises of hot shops with intensive heat input some zones with various temperatures are formed [1].

The basic part. For definition of a physical picture aerostatic, aerodynamic and the heat mass exchange processes proceeding in the conditions of changing temperatures, it is necessary to present initially a premise, as a vessel filled with an air-gas mix then under laws of aerostatics pressure change *dP* in a layer *dh* gasvariably on height and makes

$$dP = \frac{\rho \cdot g}{F} \cdot dV, \tag{1}$$

where ρ – density of gas (air), kg/m^3;

g – acceleration of free falling, m/s^2;

F – the area of cross-section section of a premise, м^2;

$V = h \cdot F$ – Volume of a column of gas (air), м^3.

As $dV = F \cdot dh$ то expression (1) will become

$$dP = \rho g dh. \tag{2}$$

Integrating expression (2) we will receive

$$P_h = P_a - g\int_o^h \rho \cdot dh, \tag{3}$$

where P_a – atmospheric pressure upon earth surfaces at $h = 0$.

In stationary conditions without any heat input air temperature indoors remains invariable. Then also air density is constant, and after integration expression (3) looks like

$$P_в = P_a - \rho g h \text{, Па.} \tag{4}$$

The physical picture described above aerostatic processes by expressions (1)–(4) is presented in figure1.

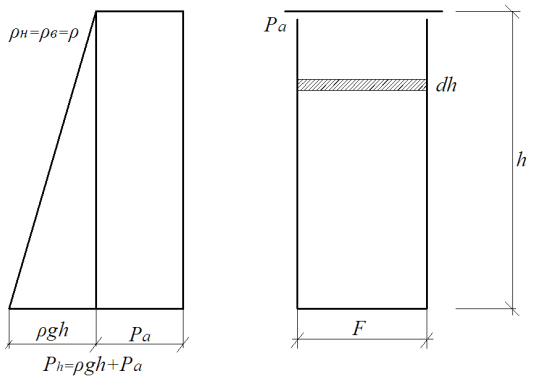

Fig. 1. Change of aerostatic pressure on premise height
at $t_н = t_в$ ($t_в, t_н$ – air temperatures accordingly inside and outside of a premise, wasps)

If in a considered premise the source ofheat input4 (Fig. 2) the physical picture cardinally changes at $t_н < t_в$ is established. The line I on the schedule (Fig. 2) corresponds to change of aerostatic pressure outside of a building according to expression $P_н = P_a - \rho_н gh$, and the line II on the schedule corresponds to change of aerostatic pressure in building $P = P_a - \rho gh$ then the remained shaded part of the schedule will correspond to difference of aerostatic pressure outside and in a building, i.e.

$$\Delta P = P_н - P_в = P_a + \rho_н gh - P_a - \rho_в gh \tag{5}$$

Whence after transformations we will receive

$$P_{гр} = \Delta P = gh(\rho_н - \rho_в). \tag{6}$$

On the schedule (fig.2) the shaded part is settlement diagram superfluous gravitational (aerostatic) pressure at action only forces of gravitation [2].

In the course of natural circulation of air streams in premises with plenty of heat characteristic zones with various temperatures are formed some.

At aeration of buildings outside of premises with plenty of heat external temperature $t_{нв}$ of air for calculation of ventilation of the summer and winter periods of year is accepted.

The temperature of air in premises from the party supply apertures $t_{пр}$ (°C) is accepted on + 5wasps above, than $t_{нв}$, i.e.

$$t_{пр} = t_{нв} + 5. \tag{7}$$

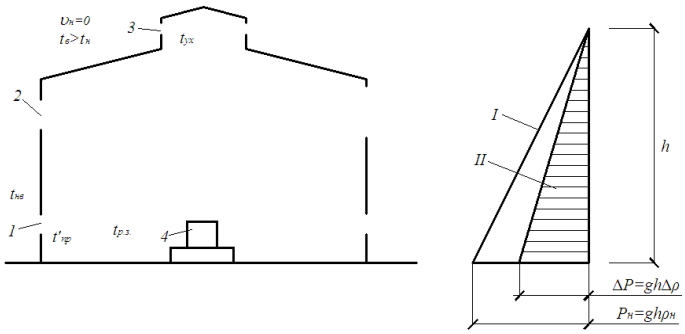

Fig. 2. Change of aerostatic pressure on premise height at $t_н < t_в$:
1 – supply apertures in the summer; 2 – supply apertures in the winter; 3 – exhaust apertures

Total influence on a building gravitational $P_{гр}$ and wind ΔP_{υ} pressure will define construction diagram pressure upon a building for the summer and winter periods of year.

On Fig. 3 constructiondiagram pressure for the summer and winter periods of year is executed at joint influence on a building gravitational $P_{гр}$ and wind ΔP_{υ} pressure, forming a thermal and air mode of buildings at aeration.

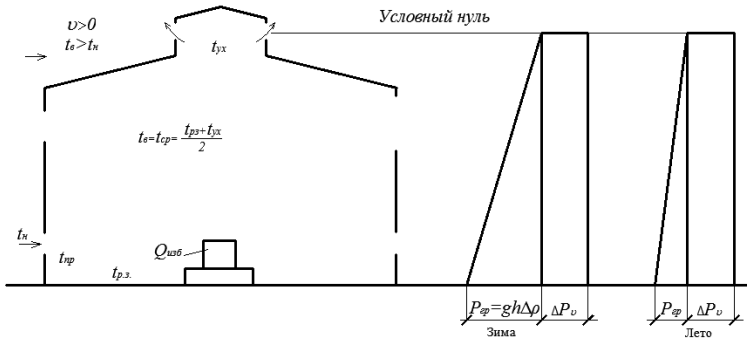

Fig. 3. Construction diagram pressure at joint influence of gravitational and wind pressure upon a building in the summer and in the winter

Dynamic processes in hot shops are closely connected with heat mass exchange. Total thermal emissions from нагретых surfaces of the furnaces which are cooling down and the fused metal are carried out for the account convection and emissions.

With a view of decrease in harmful influence on working heats from heated surfaces of active sources of heat input it is offered to apply in hot shops the technological scheme operated the screen-rolling aeration limiting a zone of heats from a working zone of premises how it is shown on fig. 4.

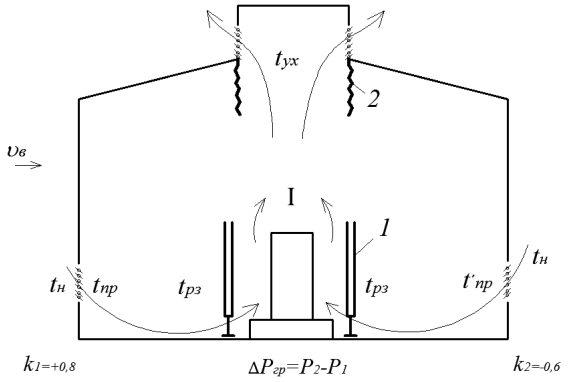

Fig. 4. The scheme operated the screen-rolling aeration limiting thermal horizontal influences in a working zone with possibility of moving of superfluous warmth ascending vertical convective by streams I, forming circulation in a building

The easy portable screens 1 executed from sheet materials, well reflecting radiant energy from the fused metal or heated surfaces of the equipment of hot shops, for example, an aluminium foil with a rigid skeleton from any profile metal, will create screened protection of a working zone.

Rolls 2 of a heat-resistant material, for example, from the fiber glass fabric, going down from above from a design aeratelantern or the exhaust mine established on a roof, allow to isolate as much as possible a working zone from active influence of getting thermal radiation from hot sources from which upwards rise convective streams overheated air.

Offered technical decisions for struggle against thermal radiation from a source of warmth of hot shops differ from all known similar devices simplicity of a design, profitability in manufacturing, by small massiveness, mobility in operation as their designs can move on shop in space on the area and on height and if necessary to be established in any place or to be dismantled for some time.

The height of screens 1, and also depth overhangrolls 2 can be regulated if necessary for achievement of the maximum effect localisation of thermal air streams and a conclusion of superfluous warmth from a working zone of hot industrial premises [3].

Analyzing and generalising the above-stated, it is possible to draw following **conclusions**:

– at aeration of shops with тplenty of heat on formation of air streams joint influence is rendered by forces of gravitation with the directed movement "from below-upwards" and horizontally directed movings of air weights under the influence of wind pressure;

– thermal influence on working from heated surfaces occurs as at the expense of emission, and convection, that causes discomfort in a working zone;

– for decrease in harmful influence on working heats, it is possible to provide necessary sanitary-and-hygienic effect by the device of special protective screens and the curtains which designs are simple in manufacturing.

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